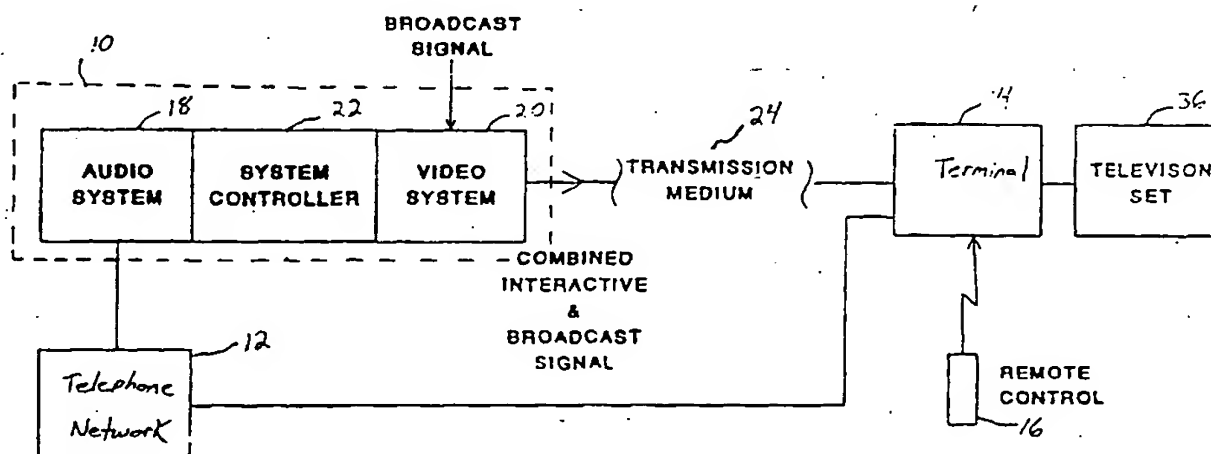


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(54) Title: TELEVISION SYSTEM DISTRIBUTING A DYNAMICALLY VARYING NUMBER OF CONCURRENT VIDEO PRESENTATIONS OVER A SINGLE TELEVISION CHANNEL



(57) Abstract

A method and system for providing, in a television system, the combination, transmission, and reception of multiple video presentations over a single channel of a television distribution system. Presentations may be concurrently broadcast for viewing by many users, as well as interactively requested for display by many (potentially a thousand or more) individual users. A presentation consists of a sequence of images which reproduce a full motion, reduced motion, or a still image video presentation for the user when displayed. The signal is transmitted in a standard television format, and consists of a sequence of video images from the various presentations being transmitted. A user terminal receiving the transmitted signal is selectably operable to display one of the multiple transmitted presentations with accompanying audio. The terminal identifies the video images of the selected presentation, stores and displays the images on an associated television receiver. The number of concurrent presentations, and the degree of motion in the presentations are dynamically variable. Interactive instructions between a user at the terminal end and the presentation system are transmitted by an associated telephone line or other communications link.

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TELEVISION SYSTEM DISTRIBUTING A DYNAMICALLY VARYING
NUMBER OF CONCURRENT VIDEO PRESENTATIONS OVER A
SINGLE TELEVISION CHANNEL

FIELD OF THE INVENTION

5 The present invention is generally directed to a
television system which is capable of concurrently dis-
tributing multiple video presentations having different
video information content over a single television channel
for receipt by different respective viewers. For example,
10 a television system in accordance with the present
invention can distribute one or more broadcast video
presentations as well as interactive service presentations
from a central presentation system, to respective viewers
with associated television sets and terminals, by means of
15 a single television channel.

BACKGROUND OF THE INVENTION

 An interactive still frame television distribution
system is disclosed, for example, in U.S. Patent No.
4,734,764. Such a system is particularly suited for
20 interactive video services such as home shopping,
financial transactions, education and the like. Generally
speaking, in this type of system a viewer sends an
indication to a central location describing a video
presentation which he desires to receive, e.g. houses
25 being offered for sale by a real estate service. Video
frames which show the available houses are individually
retrieved from a suitable video storage medium, and each
frame is labelled with an identification code which
enables it to be retrieved by the viewer who desires to
30 see it. Other viewers can independently request other

presentations available on the system. All of the frames selected by the various viewers are multiplexed onto a transmission medium, such as the trunk cable of a cable television system, and transmitted at the standard
5 television frame rate, e.g. 30 frames per second under the NTSC standard, over a channel associated with the video presentation service. Frame stores are positioned at various locations along the length of the transmission medium, and each is provided with a match code, for
10 example an address. When a video frame is labelled with the match code of a particular frame store, that frame store identifies the frame, stores it in a memory, and then continually retransmits the stored frame at the standard television frame rate to the viewer's television
15 receiver. The continually transmitted frame appears as a still frame on the viewer's television receiver. When the next frame in the presentation is required, this frame is retrieved, labelled with the appropriate code, and transmitted to the frame store for display in the same
20 manner. This process is repeated for all the frames in the still-frame presentation.

A sequence of frames may be sent for each still-frame presentation. If still frames are delivered at sufficient rate, the presentation takes on the appearance of reduced
25 motion rather than distinct still frames. For example, if frames are sent at a rate of 6 per second, 5 concurrent user presentations are possible over a single television channel (having 30 frame per second capacity) with reduced motion. Additional processing within the frame store unit
30 can interpolate several images to display additional images, with the object of producing the appearance of smoother motion.

With increasing acceptance of the value of interactive television system services, there is a clear
35 benefit to the industry to provide an efficient transmission medium for these services. The high cost of

dedicating a television channel solely to an interactive service is viable only for the largest of such services. Furthermore, it is highly desirable to include interactive capabilities with many of the broadcast services, such as distance learning, being transmitted via satellite, to provide a means for measuring the effectiveness of these services. Combining the transmission of interactive services with these services on one channel would save the cost of an additional channel while providing the benefits of interactive capabilities.

Accordingly, it is an object of the present invention to provide a television system which expands the program capacity of each channel of the television system by distributing at least two distinct presentations concurrently on a single channel. It is a further object of the present invention to address the above-mentioned needs by providing a television system which is capable of distributing multiple viewer requested (interactive) and/or broadcast video presentations, to different respective viewers by means of a single television channel, including the combination of full motion, reduced motion and still-frame video presentations. It is a further object of the present invention to provide a combination of presentations that be dynamically variable so that the system can respond to changing presentation requests over time.

SUMMARY OF THE INVENTION

The present invention provides a television system which increases the capacity of television channels by exploiting the fact that certain presentations do not require the full image capacity of a dedicated television channel and therefore the excess capacity can be used to distribute images of additional presentations over that

channel. A television signal having multiple video presentations is transmitted over a single television channel. In an exemplary embodiment of the invention, one video presentation could comprise a motion video program and other presentations could pertain to a still-frame interactive video service. The television signal is produced by a multiplexer which combines the still-frame interactive video images and motion video images into a standard (such as NTSC) sequence of images for transmission.

In one embodiment of the invention, each of the interactive video images has an identification associated therewith so that these images can be distinguished from the full motion video images, which have a distinct associated identification. A user terminal which receives the transmitted television signal can be selectably operable to display different presentations. A selection corresponds to one of the video presentations transmitted in the television signal, and causes a television receiver connected thereto to display only the corresponding video presentation. In the specific example described above, the terminal can display either the motion presentation or a still-frame interactive presentation. To display a selected presentation, the terminal identifies the video images of the television signal corresponding to the selected presentation, stores the selected images, and displays them on an associated television set. Interactive instructions between a user at the terminal end and the presentation system are carried out via the use of a communication link such as a telephone line.

Other applications of the invention are also possible. The television signal could combine two or more motion video presentations whose content is such that each presentation can be displayed at less than the standard television rate without significant quality loss to the viewer. For example, the video presentations could be a

movie and a set of educational programs, where the educational programs are scheduled to be broadcast sequentially, concurrent with the movie broadcast. Also, if two full motion video presentations are transmitted in the television signal, each one could be transmitted at a rate of 30 distinct fields per second for a total of 60 fields per second as specified by the NTSC standard. Additional applications of the invention are to provide two motion channels at 24 fields per second each, leaving 12 fields per second as excess capacity for interactive service presentations, or to provide 3 motion presentations at rates of 30, 15 and 15 fields per second respectively. The invention is dynamically variable due to the per image identification so that these applications needs can be established on a real-time basis.

The invention extends to a digital as well as analog (such as NTSC) transmission format where images are labelled with an identifier. Under a digital television format, additional digital processing such as image compression permits even greater dynamic variation in the tradeoffs between image transmission rate, image resolution and degree of compression.

The foregoing features of the invention, as well as the advantages provided thereby, are explained in greater detail hereinafter with reference to preferred embodiments illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a specific example of a sequence of image frames with certain fields being repeated to provide a full motion video sequence;

Figures 2A and 2B respectively illustrate a transmitted combined image sequence and a reconstructed full motion video sequence;

Figure 3 is a block diagram of an interactive television system which operates according to the principles of the present invention;

Figure 4 is a detailed block diagram of the terminal
5 utilized at the user's end according to the present invention;

Figure 5 is a more detailed block diagram of the presentation system in the interactive television system;
and

10 Figure 6 is a more detailed block diagram of the picture multiplexer and associated hardware according to the present invention.

15 DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

The present invention achieves increased capacity for a television channel by producing a television signal having video images from at least two distinct video
20 presentations incorporated into a signal transmitted over a single television channel. As used herein, the term "video presentation" is employed to identify video image sequences which correspond to motion television presentations as well as still-frame video presentations.
25 In its transmitted form, the video presentation could comprise an analog video signal or digitally encoded video data. Furthermore, the encoded video data could be in a digitally compressed format.

A standard television signal is comprised of multiple
30 successive images. When the television signal is transmitted in an analog form, each image is called a frame. Under the NTSC standard, for example, video images are transmitted to a standard television receiver at a rate of 30 image frames per second. A single image frame
35 presents a video-quality still image. Each image frame actually consists of two image fields which are

interleaved to increase the vertical resolution while reducing flicker in the displayed picture. The image field rate is therefore 60 fields per second. The two interleaved fields are comprised of a plurality of scan lines referred to as the vertical blanking interval (VBI) and a larger plurality of scan lines containing the video signal to be converted to a video image on the television screen.

When the television signal is transmitted in a digital format, each image is sent in a data block that corresponds to one field or frame. Digitally transmitted image data typically does not include a 'vertical blanking interval' as in the analog standards. However, each data block would typically include a header record to identify that image. In a compressed digital video signal, the image rate may be substantially higher than the analog rate of 60 image fields per second. For example, current technology can digitally compress a still video field into 10 Kbytes of data, and provide a digital transmission capacity of 20 Mbps (2.5 Mbytes/s) in an NTSC channel. Thus, 250 images may be transmitted every second on a single television channel. This capacity is sufficient to carry 4 full-motion programs on a single channel or support 2,500 interactive viewers requesting still-frames every 10 seconds or various other combinations of still and motion presentations. Technology advances are anticipated to increase channel capacity and reduce compressed image sizes, resulting in higher image rates within the transmission channel.

The television system of the present invention has the capability to transmit a signal over a single television channel having images that are respectively associated with at least two distinct video presentations. For example, the transmitted signal may comprise a sequence of images wherein every other image is associated with a first video presentation and the remainder are

associated with a second video presentation. This concept will be further explained with reference to a specific example illustrated in Figures 1, 2A and 2B. To facilitate an understanding, this particular example pertains to an analog video signal comprised of image frames.

Certain types of full motion presentations, such as movies, consist of 24 image frames per second. To convert a movie to a video signal for transmission and display in a typical television system, the 24 image frames are expanded to 30 image frames by the repetition of one video field for every two images as illustrated by way of example in Figure 1. As shown in Figure 1, a sequence of image frames corresponding to image 1, image 2, image 3, and image 4 are transmitted. Each image frame comprises two distinct fields as previously noted, e.g. image 1 includes a first field M1-1 and a second field M1-2. The actual conversion from 24 to 30 image frames per second is illustrated by the repetition of a field of image 1 as M1-3 and a field of image 3 as M3-3. Preferably, the first field is repeated to maintain full vertical resolution. The repeated field contains the same information as the previously transmitted field. In accordance with the present invention, this particular attribute can be utilized to increase the capacity of existing channels.

More particularly, the present invention effectively creates a multiplexed channel by transmitting new fields in the time slots which would normally contain a repeated field in this example. Figure 2A illustrates a video image sequence wherein fields 3 and 8 are replaced with interactive fields I1 and I2 rather than being repeated fields of the movie. At the user's end, when it is desired to view the movie, the interactive fields I1 and I2 are removed from the video signal and the appropriate previously sent field of the video signal is repeated. Figure 2B illustrates a reconstructed video image sequence

which corresponds to a full motion video movie sequence. Interactive fields I1 and I2 have been effectively replaced by the repetition of fields M1-1 and M3-1, as M1-3 and M3-3 respectively, at the user's end. This process
5 reproduces the desired video image sequence with no loss of quality. (In the case where the repeated field is the second field of the image, there could be a slight loss of vertical resolution on the repeated field) ..

Alternatively, if the user desires to access the
10 interactive service, only the field I1 and/or I2 is selectively retrieved from the video signal for display on the viewer's receiver. Each retrieved interactive field is continuously displayed on the viewer's receiver at the standard television frame rate, to provide a still frame,
15 until the next interactive field of the presentation is received.

It can therefore be appreciated that in the example described above, the present invention effectively doubles the capacity of a single channel to include the concurrent
20 transmission of, for example, 24 image frames (48 fields) per second which can be utilized for the distribution of a movie, and 12 image fields per second which can be used for an interactive service. Additionally, the 48 fields per second could be further allocated to 2 distinct
25 movies, where each movie is reproduced with full motion but has reduced vertical resolution. The reduced vertical resolution can be alleviated by the terminal with vertical interpolation of stored lines of the first field to generate the second field of a frame.

Referring now to Figure 3, an overall system diagram of a television system combining broadcast and interactive television services is illustrated. When an interactive presentation is requested, according to the present invention, the viewer sends instructions to a presentation
30 system 10 at a central location to identify one or more presentations that are desired to be viewed. These
35

instructions are transmitted from the viewer's remote location to the central location by means of a wire, fibre optic, cellular, radio or other telephone network 12. For example, the instructions might be transmitted as touch tones which the user generates by depressing buttons of the keypad on his telephone set. More preferably, however, the instructions are generated within a user terminal 14 located at the viewer's home, and transmitted over the telephone network as DTMF or modem tones on an analog line, or data on a digital line such as the ISDN format. For ease of use, the terminal 14 is preferably controlled by means of a remote control unit 16 which transmits instructions to the terminal 14 via infrared signals.

The presentation system 10 processes the incoming requests from the viewers and retrieves video images and accompanying audio associated with the presentations desired by the various viewers. In one embodiment of the invention, each image is labelled with a corresponding identification. For example, the identification might indicate the particular video presentation to which it pertains, or it may be an address identifying the viewer for whom it is intended. All of the selected video images are assembled into a video signal that is transmitted to the viewers.

The presentation system 10 basically comprises three main subsystems, an audio subsystem 18, a video subsystem 20 and system controller 22. The servicing of the incoming requests received by the audio subsystem and assembly of requested images into a video signal by these three subsystems is carried out under the management of the system controller 22. Once the various requested images have been assembled into a video signal, this signal is transmitted over a suitable transmission medium 24, such as a CATV system, a terrestrial or satellite broadcast network, or a fibre optic network.

In operation, the terminal 14 selectively stores video images and continuously displays them on the television set 36. When a viewer activates the terminal 14 to view an interactive presentation, the user terminal 14 is tuned to a channel associated with the interactive television network, e.g. channel 33. The terminal has a code relating to the identification label in the images pertaining to the interactive presentation the viewer desires to see. The user terminal examines the images transmitted over the appropriate channel for those which are labelled with the proper identification, and stores each such image, one at a time, in a memory (not shown). The stored image is continually retransmitted from the terminal 14 to the viewer's television receiver 36 for display as a still image. When the next image in a desired video presentation reaches the user terminal, it replaces the preceding image in the memory and is then displayed.

The presentation system 10 is also operable in a non-interactive display mode. The terminal will store and retransmit only the broadcast video images to the television set 36 in accordance with the process discussed with reference to Figures 2A and 2B. When the terminal is operating in the non-interactive mode, it need not be connected to the presentation system 10 via the telephone network 12.

The structure of the user terminal 14 is illustrated in Figure 4. Referring thereto, the input line to the viewer's home, such as an antenna or a drop cable 35, is connected to a signal splitter 98. One output terminal of the splitter is connected to any user accessories, such as a video cassette recorder, and then to the viewer's TV receiver by means of a control switch 100. During normal viewing, the control switch 100 is in the position shown in Figure 4, where the TV is directly connected to the input line.

The other output terminal of the splitter 98 is connected to a channel tuner 102. This tuner is adjusted to a particular television channel that carries two or more video presentations, e.g. channel 33. The adjustment
5 of the tuner to this channel is carried out by means of a control signal from a controller 104.

The tuner passes only the signal on the designated channel to which it is currently tuned. This signal comprises the sequence of encoded video image fields or
10 frames assembled in the presentation system 10 as well as any background audio signal that has been combined with the video signal. The signal carried on the designated channel is applied to a video demodulator 106, which separates the background audio signal from the video
15 information. The background audio signal is applied to a muting circuit 108. Under control of the controller 104, the muting circuit 108 selectively blocks the background audio signal or passes it along to an audio processing circuit 110.

The video information from the video demodulator 106 is presented to a video control circuit 112. This control circuit is supplied with data from the controller 104. In part, this data contains the identification code of the images that pertain to the video presentation the viewer
25 desires to see. In response to this data, the video control circuit detects information which is labelled in the vertical blanking interval of each image and determines whether any image carries the specific identification code supplied by the controller 104. If
30 the identification code is detected in the vertical blanking interval of an image, the image is gated to an image store 114. For some applications, it is also useful to optionally store images which have not been labelled. The video image stored within the image store 114 is
35 continually read out of the image store and applied to a modulator 116 at the standard television image rate. If

locally generated graphics are to be displayed with the image, for example as part of an interactive service, they are generated in a graphics generator 118 under instructions from the controller 104, and displayed with the image stored in the image store 114.

The user terminal includes telephone jacks 120 and a telephone interface 122 for the receipt and transmission of additional interactive information transmitted over the telephone lines. The audio processing circuit can be provided with a volume control switch 124 to enable the viewer to control the level of the background audio relative to the telephone audio signal, as well as control the overall volume level. If the user terminal is to be located at a place where it is not convenient to connect it to a telephone line, the telephone jacks 120 can be replaced with a wireless transmission system similar to that employed in cordless (or radio) telephones.

When the user desires to view a selected presentation, he enters appropriate commands into the controller 104. Those commands can be entered by depressing appropriate alpha-numeric keys on the remote control unit 16, which sends corresponding infrared signals to the user terminal. These signals are received in an infrared receiver 126 and forwarded to the controller. The controller actuates the control switch 100 to connect the TV receiver to the modulator 116. In addition, it provides the video control circuit 112 with the appropriate identification code associated with that presentation. In this condition, the receiver then reproduces the video presentation selected by the viewer. The appropriate identification code may also be provided from memory within the terminal, or from the presentation system sending commands to the terminal.

A more detailed block diagram of the presentation system 10 is illustrated in Figure 5. The audio subsystem comprises a number of DAS (Digital Audio System) control

units 38, and the video subsystem includes a number of DVS (Digital Video System) control units 40. Each of the control units 38 and 40 communicates with the system controller 22 by means of a local area network (LAN), for example a SCSI bus 42. All of the control units also communicate with a disk storage system 44 by means of the LAN. The disk storage system 44 stores digitized information for the various video presentations, that are available by means of the interactive service including the audio that accompanies each presentation. Preferably, the digitized audio and video information is stored in a compressed form. As illustrated in Figure 5, a single disk storage system 44 is shared by all of the DAS control units 38 and the DVS control units 40. If desired, however, separate disk storage systems could be respectively associated with the audio subsystem and the video subsystem.

The disk storage system 44 includes a multiported controller 45 having a number of ports respectively connected to the DAS and DVS control units. The controller 45 also has a number of ports respectively connected to a plurality of disk drives 46. The controller receives disk control commands, such as read and write data for example, from the DAS and DVS control units via the LAN, and sends stored data from the disks to the control units.

Each of the DVS control units 40 receives compressed, digitized video information stored in the disk storage system 44, expands it and converts it into a video signal. In addition, the DVS control units insert appropriate identification and control information into the vertical blanking interval of each image to be transmitted. The DVS control unit can also insert text which is to be overlaid upon a selected image. Once the video image has been composed within the DVS control unit, it is supplied to a picture multiplexer 58.

The picture multiplexer 58 has video input ports 60 which receive the video signals from the DVS control units 40 over video lines 61. The multiplexer has multiple output ports 62 corresponding to the number of transmission paths. Preferably, each of the input and output ports comprises an RGB video port. The picture multiplexer 58 also includes input ports 66 to accept full motion video from video processors 67 which in turn receive transmissions from video sources.

Associated with the picture multiplexer 58 is a controller 64 containing a command/status register for each DVS control unit 40. The DVS control units communicate with the controller 64 over control lines 66 to provide information which identifies the transmission path for the video image from that control unit, an indication of whether the image is to be transmitted in a field or frame format, and the input port number where the image appears. This information is written into the command/status register associated with the DVS control unit.

The controller 64 arbitrates among all of the input ports to which a video signal has been presented for transmission. Each such input port is serviced by selecting an output port based upon the identification of the transmission path in the command register, and activating an electronic switch within the multiplexer 58 to gate the input port to the selected output port at the start of the vertical interval of the next field. In this regard, master timing information for synchronizing the transmission of all of the video frames at the respective input ports is provided by a master sync signal generator 68. This generator produces horizontal and vertical interval pulse signals which are supplied to the controller 64 for the picture multiplexer and to each of the DVS control units 40. These pulses are used to control the timing with which video frames are presented

to the input ports of the picture multiplexer and switched to its output ports to thereby ensure that a continuous, synchronized video signal appears at each output port at a standard television frame rate, e.g. 30 frames per second
5 in the NTSC format.

Once the transmission of a video image (field or frame) has been completed, the controller returns an appropriate status in the command/status register for the DVS control unit from which the image originated, to
10 thereby provide an indication that the multiplexer is ready to receive the next image from the DVS control unit.

The video signals present at the output ports of the picture multiplexer 58, which are preferably in RGB format, are applied to respective NTSC composite video
15 encoders 70. Each of these encoders receives synchronizing signals from the master signal generator 68, including a reference color subcarrier, as well as horizontal and video synchronizing signals. The RGB video signals are converted to NTSC composite video signals, and
20 applied to a transmission facility 72. The transmission facility 72 has $n + 1$ audio channels, where 'n' is the motion presentation capacity. Audio channels may be on distinct carrier frequencies using analog or digital modulation, or they could be blocks of addressed audio
25 data in the same or another transmission channel as digital video images. There are n audio channels provided so there can be one audio channel corresponding to each of the broadcast motion presentations and one channel which receives background music that is to accompany the
30 interactive video presentations. Foreground audio for interactive presentations utilizes the telephone link. The output signals from the transmission facility 72 are then disseminated to the viewers. This facility can be a coaxial or fibre optic cable, a broadcast transmitter, or
35 a microwave channel for distribution to individual receivers, a CATV hub or a satellite for DBS broadcasts.

Thus, in the example described with reference to Figures 1, 2A and 2B, a signal transmitted from the presentation system 10 contains the 48 full motion video image fields per second plus the 12 interactive fields on a single television channel. This combined television signal appears at the output of the picture multiplexer 58 at the rate of 30 frames, or 60 fields, per second complete with an identification label in the vertical blanking interval of each image (frame or field).

Referring briefly to Figure 6, the process of combining broadcast video images with the interactive images will be described. In the illustrated embodiments, the full motion broadcast video images are supplied to the picture multiplexer 58 from the video processors 67, which in turn receive program signals from suitable video sources. The interactive images (still frame or motion) are supplied from the DVS control units 40. The video information from the DVS control units 40 comprises the interactive video presentations of the system described with reference to Figure 5. The picture multiplexer 58 comprises a plurality of switches 50 which are operated in response to signals from the controller 64. The switches 50 intermittently switch from the port associated with video processor 67 to a port associated with one of the DVS control units 40 to interleave the broadcast and interactive images and produce a sequence of images to be passed to each channel, in this example channels 33, 34, and 35. For the specific example of incorporating interactive fields into the image fields of a movie presentation, the controller 64 operates the switch 50 in such a manner that 12 interactive fields are interleaved with the 48 fields associated with the movie presentation to produce a television signal at the rate of 60 image fields per second on one of the associated channels.

In addition, motion detectors 69 may be associated with each of the video processors 67. The motion

detectors 69 can be of the conventional video motion detector type wherein subsequent video images are compared with previous video images to determine if there is significant motion or movement during the sequence of video images. Such a detection is helpful in situations where the broadcast video frames from the video processor 67 lack a significant amount of motion. In such a situation, certain of these broadcast video fields may be replaced without losing the quality of the video presentation so that additional interactive fields can be interleaved on that particular signal being transmitted over one of the channels of the television system. As an example, in the event that the broadcast video presentation contains portions where there is relatively little or no motion, such as a single person speaking or a stationary object, the motion detector 69 associated with that broadcast video would signal the controller 64 that an opportunity exists to incorporate additional interactive fields from a DVS control unit 40 into the television signal. The controller 64, in response to the signal from motion detector 69, will change the switch 50 to the input port associated with the DVS control unit 40 which is the source of the next interactive field. In effect, the motion detectors 69 will act as a trigger for switch 50 to connect the interactive fields to the television signal during periods of relatively little motion in the broadcast video.

When the terminal 14 at the user's end is displaying a broadcast presentation, the terminal 14 will examine the incoming identification code contained in the vertical blanking interval of each image. If the identification code matches, the signal is allowed to pass through the terminal 14 to the television set 36. In the terminal 14 the image store 114 carries out read and write operations concurrently, so that sequential fields of the broadcast program are only stored momentarily. When no identifica-

tion code match occurs, the currently stored field is repeatedly displayed until the next broadcast video field replaces it.

5 The interactive service operation is similar to that previously described with respect to Figures 3, 4 and 5. When displaying an interactive presentation, the terminal 14 ignores the other video fields and only stores and displays the interactive selected presentation fields transmitted over the particular channel of interest.

10 The above-described embodiment of the present invention is only exemplary of the capabilities provided by the invention for increasing the capacity of one or more channels in the television system. The television system may be adapted to produce varying video image rates
15 such as 30 fields per second for broadcast with reduced vertical resolution. Further, the rate could be set so as to provide still presentations with images changing at a slow rate, for example, every 5 seconds. In addition, the interactive services could be combined with one another
20 onto a single channel, or combined with other broadcast channels, with the basic operating characteristics described herein. For instance, instead of using the standard 48 fields for broadcast video, it is possible to utilize 6 fields per second or less in certain motion
25 video presentations, while utilizing the remaining 54 fields for interactive fields or other additional motion video presentations. In other words, the full range of the increased capacity as contemplated by the present invention in producing a multi-presentation channel is to
30 have from as few as 6 fields per second of a motion video presentation and 54 fields per second of various other presentations to as much as 59 fields per second of a motion video presentation and 1 other field per second associated with other presentations. These ratios can be
35 dynamically variable in accordance with the motion content of the video presentations, or pursuant to commands

entered into the controller 64 by an operator, DVS control unit, or other controller.

5 The strategy for allocation of image transmissions for a presentation is dynamically variable to accommodate the varying degrees of motion in presentations and
changing number of concurrent presentations being transmitted; as well as providing a fair allocation of the limited, fixed channel capacity to all presentations which are transmitted through the channel. A typical strategy
10 is to assign a specific value (such as 24 or 30 per second) to the full motion presentation(s), assign a range of values (such as 15 to 30 images per second) to reduced motion presentations, and preempt images as required for still-frame presentations. When the channel capacity has
15 been fully allocated, a current presentation must end or be cancelled before new presentations may be started; alternatively, the capacity must be reallocated so that all presentations may be delivered but with some at a lower image rate. A digital embodiment uses the same
20 strategies, however, the image capacity of the channel may additionally vary with different image compression ratios.

The ability to selectively combine different video presentations on a single channel provides various capabilities. For example, interactive game shows are
25 easily implemented. In such a situation, the full motion broadcast portion of a transmitted signal can comprise the normal game show presentation. For each possible answer that a viewer can choose in response to a question during the game, a separate interactive field or frame is
30 inserted into the game show transmission. Thus, when the viewer chooses a particular answer, the image associated with that answer is stored and displayed to the viewer. In addition, if points are to be awarded based on the answer, the points for any given answer can be transmitted
35 as data in the VBI of the associated image, and accumulated in a memory at the terminal, for example in a

data buffer 132. At the completion of the game, the viewer's total score is transmitted to the presentation system for tallying, and the highest scoring players can be acknowledged.

5 Furthermore, the selective combining of video presentations stored on a disk or other media with full motion, broadcast enables specialized services to be provided. For example, during the broadcast of a live sporting event, a continuously running short period of the
10 event, e.g. ten seconds, can be stored on disks 46 at the presentation system 10 for replay. Thus, if a viewer desires to see an instant replay while the game is in progress, the last ten seconds can be combined with the full motion, broadcast game presentation and retransmitted
15 to the viewer as reduced-motion fields, providing a slow-motion replay capability.

It will be appreciated that the present invention can be embodied in other specific forms without departing from the spirit or essential characteristics thereof. Although
20 the illustrated embodiment has been described with reference to its operation on a single NTSC channel, the principles of the invention can be expanded over non-NTSC channels, for instance channels which will be defined under the HDTV standard. Multiple television channels may
25 also be supported. For example, it may be desirable to provide eight different video presentations each of which contain limited motion that enable them to be transmitted at a rate of 15 fields per second without adversely affecting the perceived video quality. In such a case,
30 four of the video presentations can be transmitted at 15 fields per second on one channel, e.g. channel 33, and the other four transmitted at that rate over another channel, e.g. channel 34. When the viewer desires to view any one of the eight video presentations, for example by pressing
35 a number key on the remote control keypad, the controller 104 in the terminal 14 tunes the tuner 102 to channel 33

and inserts the appropriate match code into the video control circuit 112. If the desired presentation is on channel 33, the video control circuit sends each appropriately identified field of the presentation to the image store 114, as described previously.

If, on the other hand, the desired video presentation is one of those on channel 34, the presentation system can send a command in the VBI of frames sent on channel 33 which instructs the controller 104 to retune the tuner 102 to channel 34. This command can be directly sent from the video control circuit 112 to the controller 104 or be captured in a data buffer 132 and supplied from there to the controller 104. Alternatively, the presentation system can send a single frame or field on channel 33 which visually instructs the viewer to retune the receiver to channel 34 to receive one of the multiple video presentations transmitted over that channel.

The ability to control the terminal 14 from the presentation system 10 via commands transmitted in the VBI provides other capabilities as well. For example, a user profile can be defined for each terminal which will preselect what is seen by the viewer when the television system is first accessed. When the terminal is turned on, it can send a message to the presentation system 10 which identifies the terminal. In response, the presentation system can send commands via the VBI which cause the video control circuit 112 to be supplied with appropriate match codes corresponding to the stored profile for that terminal, so that the appropriate video presentation will be displayed. In this regard, different remote control units 16 for a terminal can have different respective profiles, so that the initial message sent from the terminal to the presentation system identifies the remote control unit and therefore the user as well as the terminal, so that the appropriate profile is selected.

Other control means beside the VBI channel are also available, such as over the communications link if the terminal is being used interactively.

Furthermore, if the terminal controller 104 is
5 connected to a peripheral device such as a VCR,
instructions sent from the presentation system 10 can be
used to provide the viewer with any desired programming.
For example, based upon demographic or other data the
presentation system can send a VBI command to a certain
10 class of subscribers to cause their video cassette
recorders to record or playback a program transmitted at a
certain time.

The presently disclosed embodiments are therefore
considered in all respects to be illustrative and not
15 restrictive. The scope of the invention is indicated by
the appended claims rather than the foregoing description,
and all modifications that come within the meaning and
range of equivalence thereof are intended to be embraced
therein.

20

WHAT IS CLAIMED IS:

1. A television system, comprising:
 - a television distribution network for
5 transmitting multiple video presentations over at least one channel to a plurality of remotely located terminals each having at least one television receiver associated therewith;
 - a centrally located presentation system for
10 assembling video presentations to be transmitted by said television distribution network, said presentation system comprising:
 - (1) at least one video presentation
15 source, producing video image sequences corresponding to respective video presentations, said video image sequences each having a plurality of images;
 - (2) a multiplexer which receives at least one of said video image sequences and combines them with other images to produce a transmission image
20 sequence having a number of images, said transmission image sequence comprising a plurality of interleaved images from different video image sources;
 - (3) signal encoding means to encode said
25 transmission image sequence into a television signal complying with the television signal format of said television distribution network; and
 - (4) transmitting means for transmitting
said television signal over said television
distribution network;
- 30 said plurality of remotely located terminals each further comprising:
 - (1) receiving means for receiving said
television signal from said television distribution
network,

(2) decoding means to decode said television signal into said transmission image sequence,

5 (3) identification means for determining whether a received image in said transmission image sequence is associated with one of said video presentations,

(4) selection means for selecting video images associated with a specified video presentation to be displayed, and

10 (5) capture means to store said selected video image and display means to continuously retransmit said image to said associated television receiver at the standard television rate of the receiver.

2. A television system according to claim 1, wherein said plurality of images of said transmission image sequence are analog video images.

20

3. A television system according to claim 2, wherein said plurality of images are video frames.

4. A television system according to claim 2, wherein said plurality of images are video fields.

25

5. A television system according to claim 1, wherein said plurality of images of said transmission image sequence are blocks of digitally encoded image data.

30

6. A television system according to claim 5, wherein the data in said blocks is compressed to remove redundant information.

35 7. A television system according to claim 1 where the rate of image transmission of any video presentation

over the television system is less than the image rate capacity of the television signal.

8. A television system according to claim 7 where
5 the television signal is encoded in the NTSC format.

9. A television system according to claim 7 where the television signal is encoded in the PAL format.

10. A television system according to claim 7 where
10 the television signal is encoded in a digital format.

11. A television system according to claim 1 where
15 transmitted images have an identification code.

12. A television system according to claim 11, where
the selection means of the terminal matches a labelled
image identification code with the identification of the
presentation selected for display.

13. A television system according to claim 11, where
20 the selection means of the terminal detects the absence of
a labelled image identification code in the received
image.

14. A television system according to claim 1, where
25 the motion presentation image rate is less than the
standard television rate, and the terminal generates
missing images to produce the appearance of full-motion on
30 the television receiver.

15. A television system according to claim 1,
further including audio accompanying the presentations.

16. A television system according to claim 15, where the audio is transmitted along with video in the audio bands of the television signal.

5 17. A television system according to claim 15, where the audio is transmitted as separate signals over the television distribution network.

10 18. A television system according to claim 1, where presentation system commands accompanying the image cause the terminal to select another presentation.

15 19. A television system according to claim 1, where presentation system commands accompanying the image cause the terminal to select another television signal to receive from the television network.

20 20. A television system according to claim 1, where the specific video presentation to display is selected by the viewer using a remote control.

25 21. A television system according to claim 1, where the specific video presentation to display is selected by the identification of the user or terminal.

22. A television system according to claim 1, where the specific video presentation to display is specified by data sent from the presentation system to a terminal.

30 23. A television system according to claim 1, wherein said multiplexer comprises a switch controlled by a controller, said switch comprising:

(1) a plurality of input ports, each receiving a video image sequence;

35 (2) an output port producing a video image sequence;

(3) switching means which selectively switches between said input ports on individual video image boundaries, in order to interleave said plurality of images of said video image sequence received at said input ports to produce said transmission image sequence on said output port;

said controller further comprising control means to control said switch, and

selection means to determine an image switching sequence.

24. A television system according to claim 23, where presentation identifications are labelled in the images by the controller.

15

25. A television system according to claim 23, further including selection means to determine the image switching sequence between input ports according to determination strategies which dynamically vary between one or more of the following:

- (1) assign equally to each port;
- (2) assign in proportion to specified degree of motion required on output;
- (3) assign in proportion to degree of motion present in input;
- (4) use preemption of assigned image capacity by higher priority still-frame requests;
- (5) assign based on a time schedule; or
- (6) assign based on operator specifications.

30

26. A television system according to claim 25, where image boundaries are synchronized to the beginning of the vertical blanking interval in analog video formats.

27. A television system according to claim 25, where image boundaries are at the beginning of image data blocks in digital formats.

5 28. A television system according to claim 23, where multiple output ports provide multiple transmission image sequences.

10 29. An interactive television system, comprising:
a television distribution network for
transmitting multiple video presentations over at least
one channel to a plurality of remotely located terminals
each having at least one television receiver associated
therewith;
15 a centrally located presentation system for
producing video presentations to be transmitted by said
television distribution network, said presentation system
comprising:
 (1) a plurality of broadcast video presentation
20 sources, each producing a video image sequence
corresponding to a broadcast video presentation, said
video image sequence having a plurality of images;
 (2) an interactive video presentation source
which produces interactive video images corresponding
25 to an interactive video presentation to be
transmitted by said television distribution network;
 (3) a multiplexer which receives said
interactive video images and said broadcast images
and combines them to produce a transmission image
30 sequence having a number of images, said transmission
image sequence comprising a plurality of interleaved
images of said broadcast video images and interactive
video images;
 (4) signal encoding means to encode said
35 transmission image sequence into a television signal

complying with the television signal format of said television distribution network; and

(5) transmitting means for transmitting said television signal over said television distribution network;

said plurality of remotely located terminals each further comprising:

(1) receiving means for receiving said television signal from said distribution network,

(2) decoding means to decode said television signal into said transmission image sequence,

(3) identification means for examining said received transmission image sequence and identifying whether each image pertains to one of said interactive video presentations or said broadcast video presentations,

(4) selection means for selection of video images associated with an interactive video presentation or a broadcast video presentation to be displayed, and

(5) capture means to store said selected video images and display means to continuously retransmit said images to said associated television receiver at the standard television rate of the receiver.

30. A television system according to claim 29, wherein each of said remotely located terminals further comprises means for sending interactive instructions to said centrally located presentation system when an interactive video presentation is selected.

31. An interactive television system according to claim 30, wherein said means for sending interactive instructions is a via a telephone network as DTMF tones.

32. An interactive television system according to claim 30, wherein said means for sending interactive instructions is a via a data communications link.

5 33. An interactive television system according to claim 32, wherein said data communications link is via a telephone line.

10 34. An interactive television system according to claim 32, wherein said data communications link is via a 2-way CATV system.

15 35. An interactive television system according to claim 32, wherein said data communications link is via a wireless broadcast link.

36. An interactive television system according to claim 29, wherein said multiplexer comprises a switch controlled by a controller, said switch comprising:

- 20 (1) a first input port for receiving an interactive video image sequence;
- (2) a second input port for receiving a motion video image sequence;
- (3) an output port producing a video image sequence;
- 25 (4) switching means which selectively switches between said interactive input port and said broadcast input port on individual video image boundaries, in order to interleave said plurality of images of said interactive and broadcast video images provided at said input ports to
- 30 produce said transmission image sequence on said output port;

 said controller further comprising control means to control said switch, and

35 selection means to determine an image switching sequence.

37. An interactive television system according to claim 29, further comprising a trigger means for controlling said switching means to switch from said second input port to said first input port in response to detecting a first predetermined condition.

38. An interactive television system according to claim 37, wherein said trigger means comprises a video motion detector.

39. An interactive television system according to claim 37, wherein said first predetermined condition is a lack of motion in said broadcast video presentation.

40. A television system according to claim 29, with audio accompanying the presentations.

41. A television system according to claim 40, where the audio is transmitted along with video in the television signal.

42. A television system according to claim 40, where the audio is transmitted in analog form over a telephone link.

43. A television system according to claim 40, where the audio is transmitted in digital form over a telephone link.

44. A television system according to claim 43, where the telephone link is wireless.

45. A method for broadcasting multiple interactive video presentations and multiple broadcast video presentations on a single channel of a television distribution network from an interactive television system

to a plurality of terminals having television receivers associated therewith, and for providing only one of said interactive video presentations or said broadcast video presentations at a time to individual television receivers, comprising the steps of:

- providing interactive video images and broadcast video images, each of said interactive video images having an associated identification labelled therein;
- combining said interactive video images and said broadcast images to produce a transmission image sequence having a number of images including a plurality of said broadcast video images and a plurality of said interactive video images interleaved therein;
- encoding said transmission image sequence into a television signal;
- transmitting said television signal on said television distribution network to said terminals;
- receiving said television signal by at least one of said terminals;
- decoding said television signal into an image sequence;
- identifying whether each image of said image sequence is associated with one of said interactive video image presentation or said broadcast image presentation in accordance with said labelled identification;
- selecting one of said interactive video presentation and said broadcast video presentation for display on a television receiver associated with at least one of said terminals;
- storing each image of said selected presentation and displaying said selected presentation on the television receiver associated with at least one of said terminals;
- inhibiting the storage of non-selected video images of said image sequence and continuously displaying

a previously received video image to the television receiver at the standard television rate; and

5 sending interactive instructions of an operator to said interactive television system in response to said interactive instructions being sent to the terminal by the operator.

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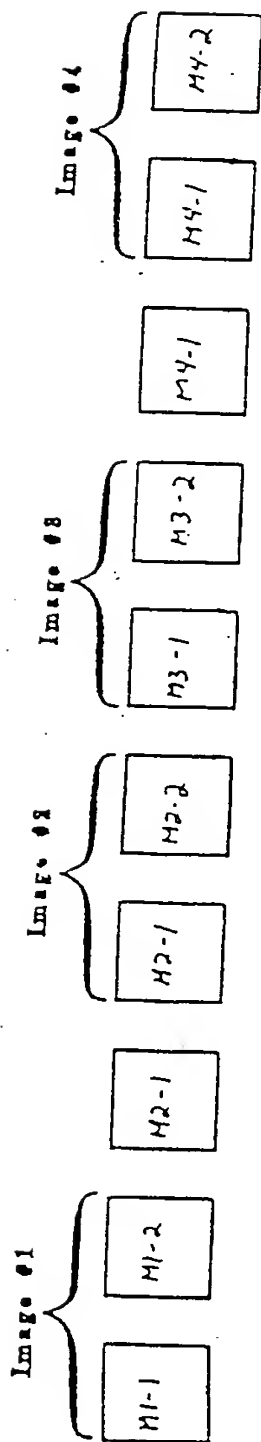


FIGURE 1

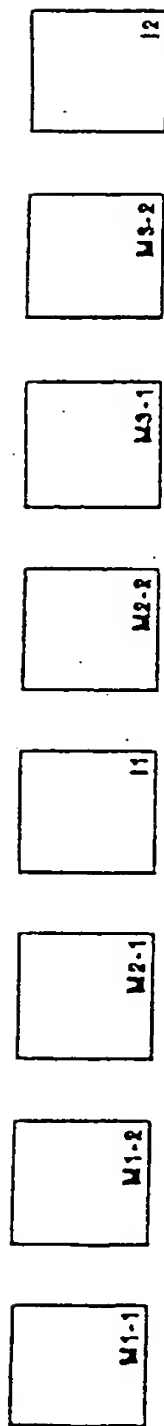


FIGURE 2A

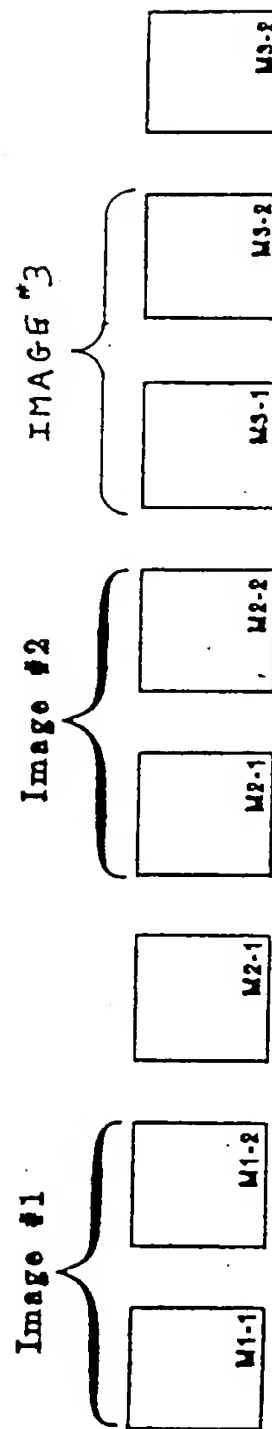


FIGURE 2B

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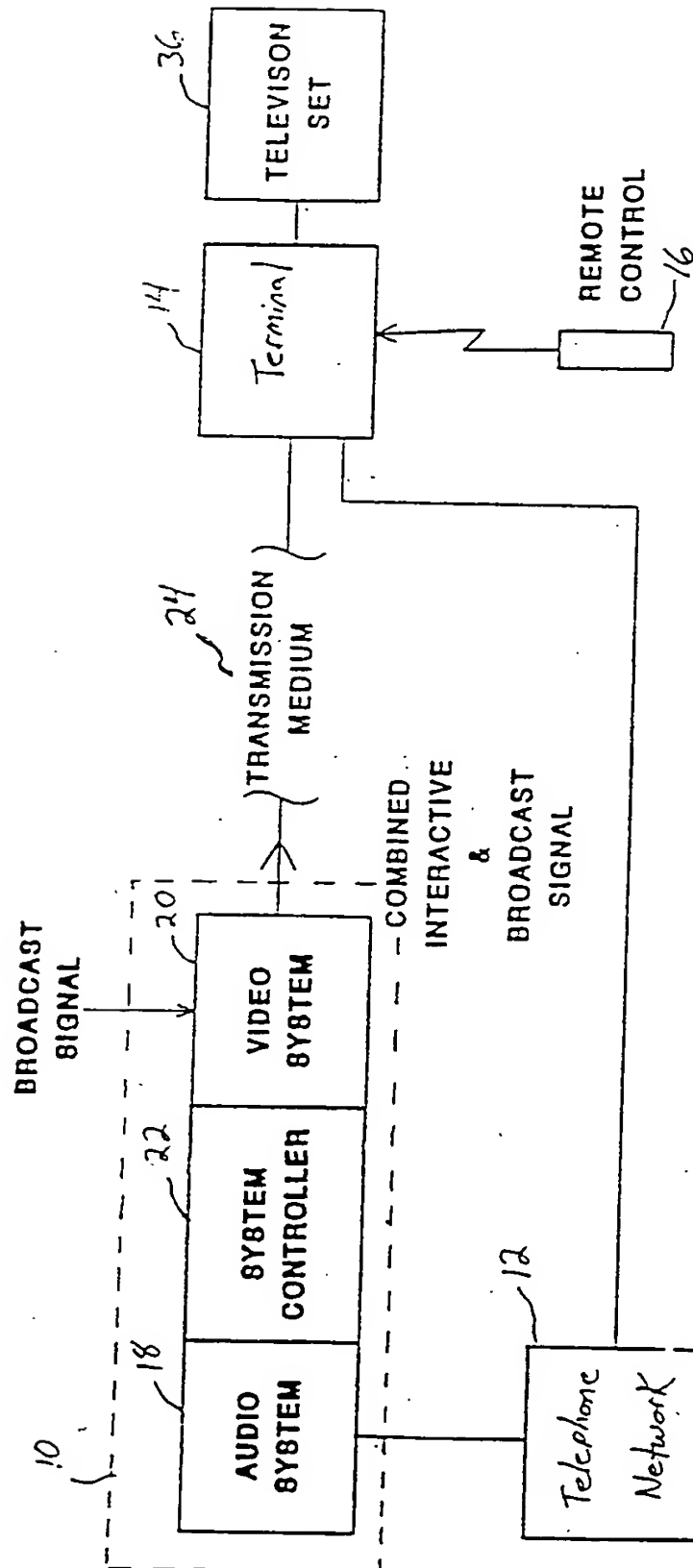


FIGURE 3

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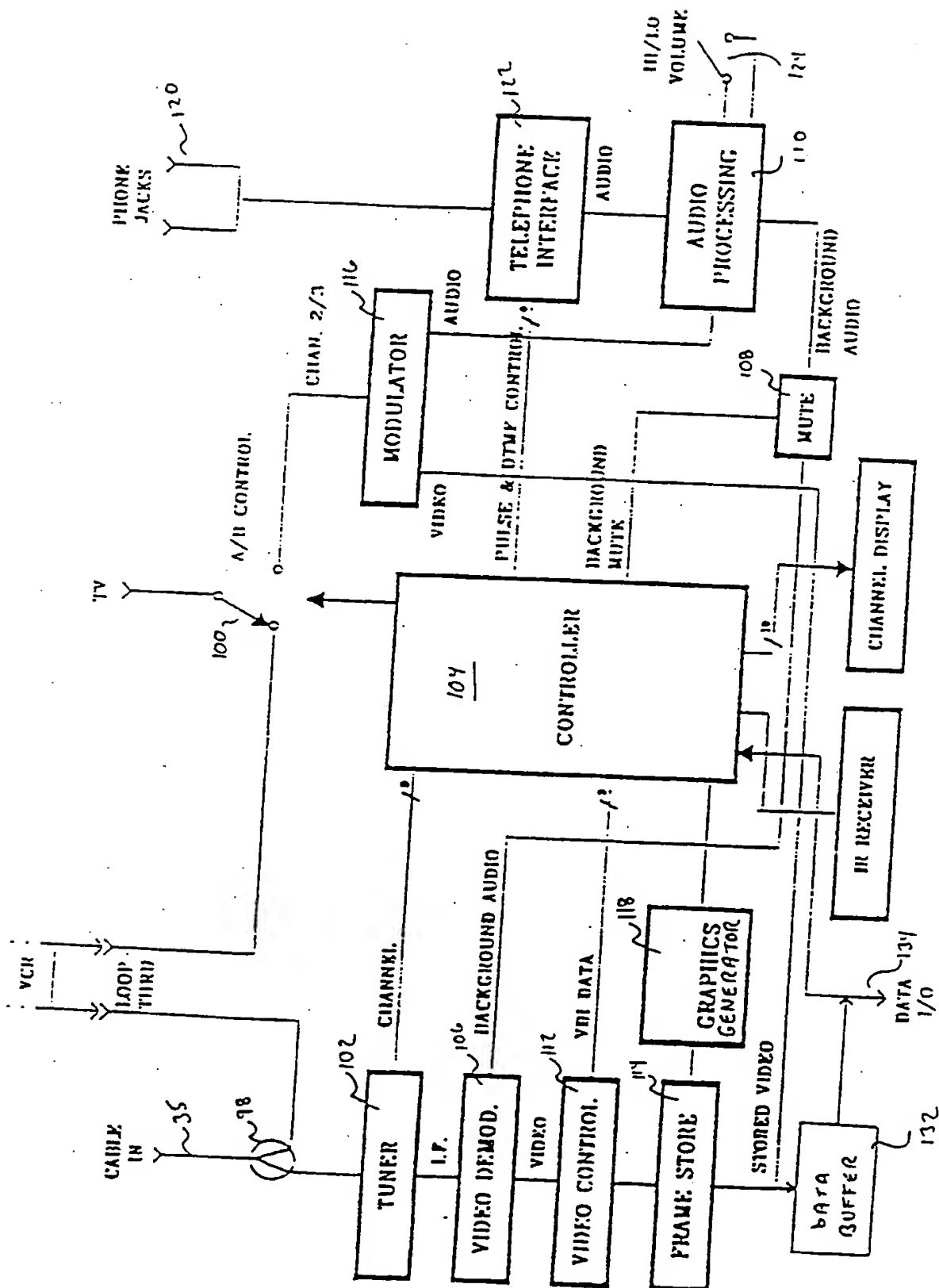


FIGURE 4

SUBSTITUTE SHEET

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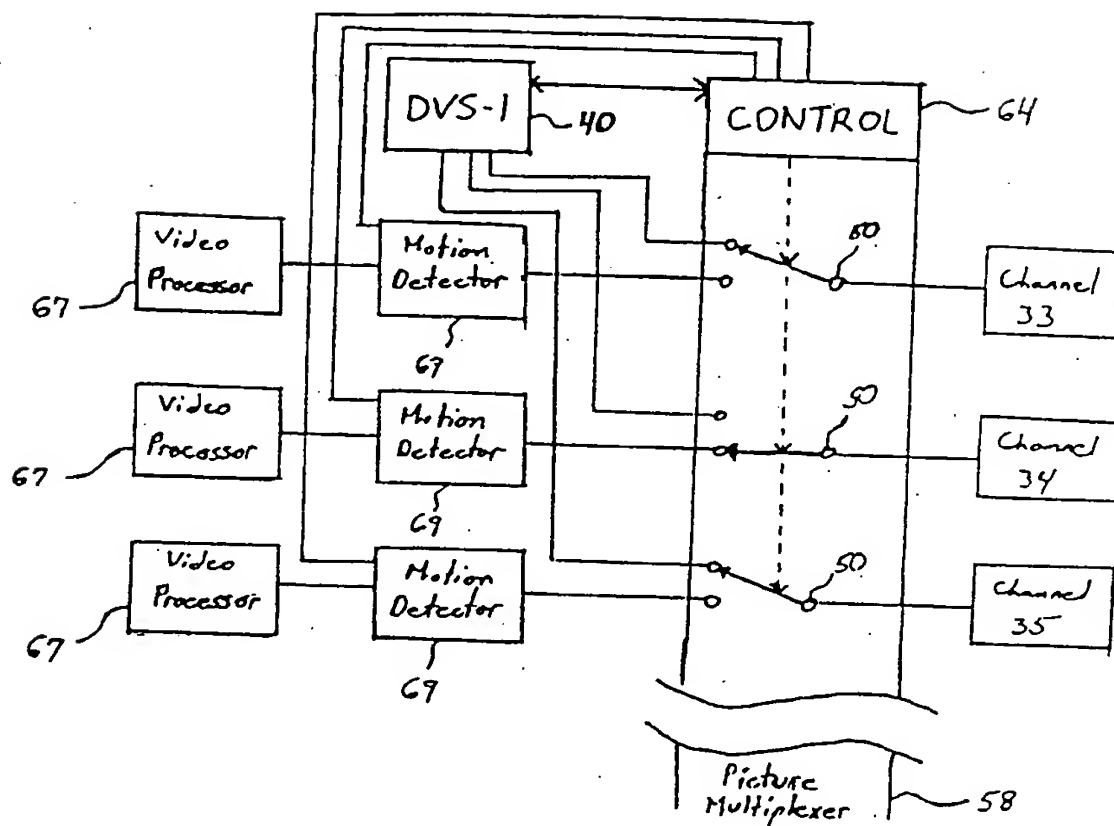


FIGURE 6

INTERNATIONAL SEARCH REPORT

Intern. Application No.

PCT/CA. 94/00581

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04N7/08 H04N7/173

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,5 113 496 (MC CALLEY ET AL) 12 May 1992 see column 14, line 43 - column 15, line 23 see column 35, line 1 - column 38, line 20 see column 39, line 21 - line 67 see figures 2,10-12 ---	1-45
A	EP,A,0 396 062 (CABLESHARE INC.) 7 November 1990 see page 4, column 4, line 11 - page 8, column 11, line 42 see page 14, column 24, line 52 - page 15, column 26, line 19 see figures 1-5 --- -/--	1-45

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- *&* document member of the same patent family

Date of the actual completion of the international search

4 January 1995

Date of mailing of the international search report

19.01.95

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>SMTE JOURNAL, vol.99, no.3, March 1990, WHITE PLAINS, NY, US pages 209 - 213, XP124199 R.J. BUTLER 'Time for Two: A Video TDM System that Maintains Spatial and Temporal Resolution for Two Pictures from Different Uplinks' see the whole document -----</p>	1-4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/CA 94/00581

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		CA-A- 2010867	08-09-90
		AU-A- 2043988	09-02-89
		DE-A- 3820425	16-02-89
		FR-A- 2619273	10-02-89
		— GB-A- 2207838	08-02-89
		JP-A- 1106541	24-04-89
		LU-A- 87305	02-02-89
		NL-A- 8801259	01-03-89
		SE-A- 8801613	05-02-89
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